

TITLE: INT-EM-05-04 Monitoring Host Selection Behavior and Progression of Infestation by the Mountain Pine Beetle, in Mixed Stands of Limber and Lodgepole Pine

LOCATION: Medicine Bow National Forest and Shoshone National Forest, Wyoming

**DURATION: year 2 of 3-year project
Base**

FUNDING SOURCE:

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COOPERATORS: USDA Forest Service working in Wyoming – Kurt Allen, Bill Schaupp, Kathy Roche, Kelly Burns, Ellen Jungck, Karl Brauneis; USDA Forest Service, Pacific Southwest Research station, Davis, CA – Steve Seybold; University of Wyoming – David Williams, Diana Dean; and University of North Dakota – Bjorn Dahlen

PROJECT OBJECTIVES: This study focuses on monitoring the parameters of the life cycle, phenology, and host selection behavior of MPB in limber pine to:

- 1) Determine the phenology of main developmental stages and developmental success in hosts of MPB;
- 2) Assess the course of infestation progression in mixed stands of lodgepole and limber pines;
- 3) Identify the host of origin of MPB in mixed stands.

JUSTIFICATION:

The proposed study satisfies **all** criteria of FHM Detection Monitoring:

- a) Its need arises from an analysis of FHM survey data (aerial survey);
- b) Significance in terms of the geographic scale: Limber pine stands account for 8% of Wyoming vegetation, while in the Medicine Bow National Forest their proportion is even higher, over 11%. However, the findings of the project should be applicable to a much larger geographic area in the several neighboring states, where limber and lodgepole pines are the primary cover types in forest stands;
- c) Biological impact of the MPB is well known. It is the most devastating insect forest pest in the west. Consequently, the political importance of the issue is extremely high, since MPB affects vast areas of national forests, wilderness reserves or high use areas;
- d) The proposed time-frame of the project (3 years, with logical step-by-step progression) warrants its feasibility and successful completion.

DESCRIPTION

a. Background: The MPB is the most economically significant forest insect in western N. America. Historically, host selection behavior by MPB has been studied in lodgepole pine. However, recent FHM aerial survey data for Wyoming indicate a strong association of MPB with limber pine, including the potential for MPB to build its population in limber pine prior to shifting to more extensive stands of lodgepole pine. This appears to indicate a new phenomenon in the life strategy of the pest, with potentially very serious consequences for the forest health. There are only limited data available on the interactions of MPB with limber pine, which warrants investigation.

b. Methods:

1. Assessment of the course of infestation of MPB in fixed plots containing both limber and lodgepole pines.
Based on aerial survey data provided by FHM, an area of the Medicine Bow National Forest near Laramie, WY has been selected as a study site. The site contains both limber and lodgepole pines as primary forest cover types, with significant levels of tree mortality attributed to MPB. This tree mortality appears to be increasing with time. At this site, ten fixed radius survey plots (1 chain in radius) will be established to assess the course of infestation by MPB during the 2005 and 2006 flight seasons. In the northern Rocky Mountains, MPB flies primarily between July and

September and is univoltine. The criteria for establishing the survey plots are 1) a mixture of limber and lodgepole pines in the stand; 2) evidence of current infestation by MPB; 3) at least three attacked limber pine trees showing expected emergence in summer of 2005; and 4) residual uninfested specimens of limber and lodgepole pines in the stand. Typically, both pine species co-occur at lower elevation ridge tops (2800-2900 m) with limber pine on the periphery of the stand.

For all trees greater than 12.5 cm in diameter at breast height (dbh), survey measurements will include: 1) species, 2) dbh, 3) height, 4) infestation status (e.g. dead and previously attacked, live and previously attacked, or unattacked), and 5) foliage color (green, yellow-green, yellow, red, or brown). For attacked trees, data collected will be the number of pitch tubes and number of exit holes within a 10 cm by 10 cm randomly selected sample area, and whether live brood are present in the tree. This survey data will be recorded in May and June, and September and October of each field season.

Another method for assessment of the progression of infestation is the high resolution, color-infrared (CIR) aerial digital photography, provided by the Cooperators from UMAC-UND. UND's Airborne Environmental Research Observational Camera, or AEROCam, is a multi-spectral aerial digital imaging system, capable of acquiring data in four visible and near-infrared bands with up to ½ -meter resolution and a field of view of about ½ square mile, which may be instrumental in evaluating the spatial parameters of the infestation in the research plots. AEROCam photos of all plots in the study area will be taken once a year and analyzed using a special GIS for processing remotely sensed data (ERDAS-Imagine®).

2. Determination of MPB flight periodicity within research study sites.

Two pheromone-baited traps will be placed at the periphery of each research plot described above. The traps are 12-unit Lindgren funnel traps baited with a 3-component pheromone consisting of terpinolene (host attractant), *trans*-verbenol (female-produced pheromone component) and *exo*-brevicomin (male-produced pheromone component). Traps and baits are provided by cooperators from the US FS. Traps will be emptied weekly between early May and mid-October. Baits will be replaced approx. every four weeks. Mean weekly trap catches of adult MPB will be recorded and plotted over the course of each summer.

3. Determination of host of origin of MPB.

The analyses will be performed in the Stable Isotope facility of the University of Wyoming, under the supervision of the collaborator David Williams (Associate Professor, Dept. of Renewable Resources). Feeding and development of MPB on various pine species reflect the dietary impacts of the respective hosts. Organic compounds from host pine phloem are ingested, metabolized and incorporated into MPB body tissues. A recently developed technique to determine the origin and history of organic compounds in biological systems is compound specific isotope analysis (CSIA) by isotope ratio mass spectrometry (IRMS) following on-line combustion of compounds by gas chromatography: GC-C-IRMS. Organic compounds, in particular, the ratio of ¹³C and ¹²C present in the phloem of limber and lodgepole pines may have different biochemical origins. Diet reconstruction of MPB that have fed and developed on different host trees may show differences in ¹³C/¹²C ratios. This hypothesis will be tested by rearing new MPB adults from each host, separating the emerged adults by sex, freezing and grinding approx. 25 adults of each treatment group in liquid nitrogen, and analyzing the individual adults for ¹³C/¹²C ratio by GC-C-IRMS. If there is a significant difference in this ratio between sexes or between specimens from host populations (two-way ANOVA), then wild populations of MPB will be flight-trapped in response to pheromone in the research plots and the diet reconstruction technique applied. If most of the beetles caught in flight during the first season are shown to have developed in limber pine, and most of the beetles caught during subsequent seasons are shown to have developed in lodgepole pine, then these data may have implications for infestation progression of MPB.

c. Products:

- 1) Flight periodicity of adults MPB in limber pine will be identified;
- 2) The directionality of the progression of infestation (limber -> lodgepole, lodgepole -> limber) will be identified and used as a predictive indicator of the course of infestations in western pine forests. The diet reconstruction methodology for determining the host of origin of bark beetles using GC-C-IRMS will be a novel and useful product for bark beetle monitoring and management in the future. All of these products will be documented through publications in the peer-reviewed scientific literature, in US FS, WY State Forestry Division, or University of Wyoming extension literature. Possible radio shows, newspaper articles, seminars, and bulletins may also be produced as needed.
- 3) Another detection monitoring tool of a GIS-based, advanced high-resolution aerial survey methodology will be developed using AEROCam technology.

4) "Hazard maps" showing the predicted areas of the course of MPB infestation will be developed for the study areas.

d. Schedule of activities:

Year 1: Establishment of research plots in Medicine Bow National Forest; collection of field data on MPB flight periodicity; collection of data for the analyses of MPB reared from the limber and lodgepole pines.

Year 2: Continuation of data collection in the Medicine Bow Forest plots; assessment of the infestation progression between years 1 and 2; laboratory analyses of the host of origin, AEROCam photos; preparation of extension publications; reporting of results.

Year 3: Continuation of data collection in the Medicine Bow National Forest; assessment of the infestation progression between years 1, 2, and 3; establishment of research plots in Shoshone National Forest and data collection to validate the project findings; AEROCam photos in both forests; development of a GIS high-resolution aerial survey methodology; preparation of publications, organization of workshops.

e. Progress/Accomplishments:

Data collected in 2004 from the ten research plots show 38 attacked and 831 unattacked lodgepole pines, and 113 attacked and 202 unattacked limber pines. Thus, the observed attack frequency for lodgepole pine is 1:22 and that for limber pine is 1:1.8. In the ten plots, lodgepole outnumbers limber pine by a factor of 3 to 1, yet the proportion of attacked limber pine (36%) is almost 10 times higher than the attacked lodgepole (4%). Data are still being collected for 2005.

Data from pheromone-baited funnel traps from 2004 indicate that the flight period of the MPB in the Medicine Bow was very long, stretching from mid-June to early October, with a peak in late August. Thus, these data suggest that the period when pines may be attacked by MPB may be much longer than previously thought. Trap data from 2005 is still being collected.

Stable isotope results from reared MPB indicated significantly different signal values in the N¹⁴/N¹⁵ ratio of lodgepole pine and limber pine. The difference in tree signal values was identifiable in tissues of MPB reared from their respective host. There were identifiable differences between the C/N ratios of lodgepole-reared MPB and limber-reared MPB as well. Samples were subsequently prepared of MPB from emergence cages attached to 10 different lodgepole pine trees and emergence cages attached to 10 different limber pine trees. These samples are currently being processed in 2005.

All of the activities under "Schedule of Activities" proposed for Year 1 have been completed. Year 2 schedule of activities are in progress.

COSTS (budget justification available upon request):

	Item	Requested FHM EM Funding	Other – Source Funding	Source
YEAR 2				
Administration	Salary	6,500		
	Overhead (40%)		6,560	U. of Wyoming
	Travel	2,000		
Procurements	Contracting	5,400		
	Equipment	1,300		
	Supplies	1,200	500	Cooperators
		16,400		

Year 3 request of FHM funding will be \$17,000.